

SECTION 11000 - EQUIPMENT GENERAL PROVISIONS

City of San Diego, CWP Guidelines

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

- A. The WORK of this Section includes providing general requirements for the WORK of applicable Sections of these Specifications. Unless there are more restrictive requirements in the individual Sections, the provisions of this Section shall apply.
- B. The WORK of this Section applies to the WORK of the following Sections:
 - 1. Section 11030 Variable Speed Drives, General
 - 2. Section 11175 Pumps, General
 - 3. Section 11260 Chemical Feeding Equipment, General
 - 4. Section 11290 Hydraulic Gates, General
 - 5. Section 11370 Blowers, Compressors and Vacuum Pumps, General
 - 6. Section 14600 Hoists and Cranes, General
 - 7. Equipment in Divisions 11, 13, 14, 15 and 16.

1.2 RELATED SECTIONS

- A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.
 - 1. Section 01300 Contractor Submittals
 - 2. Section 01660 Facility Startup
 - 3. Section 01680 Physical Checkout; Shop, Field, and Functional Testing
 - 4. Section 05120 Structural Steel
 - 5. Section 05500 Miscellaneous Metalwork
 - 6. Section 09800 Protective Coating
 - 7. Section 11002 Equipment Supports, Grouting and Installation
 - 8. Section 11005 Machine Alignment
 - 9. Section 11020 Vibration and Critical Speed Limitations
 - 10. Section 13300 Instrumentation and Control
 - 11. Section 15000 Piping Components
 - 12. Section 15020 Pipe Supports
 - 13. Section 15050 Vibration Isolation
 - 14. Section 16030 Electrical Tests
 - 15. Section 16040 Electric Motors
 - 16. Section 16050 Basic Electrical Materials and Methods

1.3 CODES

- A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:
 - 1. Uniform Mechanical Code (UMC)

2. Uniform Plumbing Code (UPC)
3. Uniform Fire Code (UFC)
4. National Electrical Code (NEC)
5. Uniform Building Code (UBC)

1.4 SPECIFICATIONS AND STANDARDS

- A. Except as otherwise indicated, the applicable standards of the following organizations apply to the WORK of this Section:

1. American Society for Testing and Materials (ASTM)
2. American Public Health Association (APHA)
3. American National Standards Institute (ANSI)
4. American Society of Mechanical Engineers (ASME)
5. American Water Works Association (AWWA)
6. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
7. American Welding Society (AWS)
8. National Fire Protection Association (NFPA)
9. National Electrical Manufacturers Association (NEMA)
10. Antifriction Bearing Manufacturers Association (ABMA)
11. American Gear Manufacturers Association (AGMA)

- B. The current editions of the following apply to the WORK of this Section:

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| 1. | ABMA 9 | Load Ratings and Fatigue Life for Ball Bearings |
| 2. | ABMA 11 | Load Ratings and Fatigue Life for Roller Bearings |
| 3. | ANSI B16.1 | Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800 |
| 4. | ANSI B16.5 | Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys |
| 5. | ANSI B46.1 | Surface Texture |
| 6. | ANSI S12.6 | Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors |
| 7. | ANSI/ASME B1.20.1 | General Purpose Pipe Threads (Inch) |
| 8. | ANSI/ASME B31.1 | Power Piping |
| 9. | ANSI/AWWA D100 | Welded Steel Tanks for Water Storage |
| 10. | AWWA C206 | Field Welding of Steel Water Pipe |
| 11. | ASTM A 48 | Specification for Gray Iron Castings |
| 12. | ANSI A 58.1 | Minimum Design Loads for Buildings and Other Structures |

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| 13. | ASTM A 108 | Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality |
| 14. | ANSI/NFPA 70 | National Electrical Code |
| 15. | MIL STD 167-2 | Mechanical Vibrations of Shipboard Equipment (Reciprocating Machinery and Propulsion System and Shafting) |

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. Manufacturer's product data including catalogue cuts.
2. Equipment name, identification number and specification numbers.
3. Shop drawings showing details, dimensions, anchorage details, and installation of equipment with all special fittings, appurtenances and required clearances.
4. Shipping weights.
5. Calculations of equipment anchorage forces and anchorage details.
6. Certification that the single manufacturer accepts the indicated unit responsibilities.
7. Parts list with materials of construction by ASTM reference and grade.
8. List of at least 5 installations and telephone numbers, where identical equipment has been used.
9. Documentation of experience of specialist who will perform torsional and vibration analysis.
10. Torsional and lateral vibration analysis reports.

1.6 OWNER'S MANUAL

A. In addition to the requirements of paragraph 01300-1.5, the following shall be included in the OWNER'S MANUAL submittal in compliance with Section 01300:

16. Manufacturer's catalog including installation instructions.
17. Manufacturer's operating and maintenance procedures including lubricating instructions.
18. Manufacturer's certification that products comply with the indicated requirements.
19. Bearing L-10 life calculations.
20. Certification that products have been factory-tested and found to conform with the contract requirements.
21. Certification that the WORK has been field-tested and the WORK complies with the indicated requirements.
22. Equipment tolerances
23. Electrical data including control and wiring diagrams.
24. Address and telephone number of local service representative.

1.7 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment:** In accordance with the requirements of Sections 01660 and 01680, an authorized service representative of the manufacturer shall visit the site and witness the following:

1. Installation of the equipment.
2. Inspection, checking, and adjusting the equipment.
3. Startup and field-testing for proper operation.

4. Performing field adjustments to ensure that the equipment installation and operation comply with the Specifications.

B. Instruction of OWNER'S Personnel

1. An authorized service representative of the manufacturer shall instruct the OWNER'S personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Training shall be specific to the models of equipment provided.
2. The representative shall have at least one year of qualified experience in training covering the relevant subjects described in paragraph 11000-1.7B.1. A resume for the representative shall be submitted to the CONSTRUCTION MANAGER.
3. Training shall be scheduled a minimum of 3 weeks in advance of the first session.
4. Proposed training material and a detailed outline of each lesson shall be developed in accordance with the requirements specified in Section 01300, and submitted to the CONSTRUCTION MANAGER for review. Comments from the CONSTRUCTION MANAGER shall be incorporated into the material.
5. Training materials shall remain with the trainees.
6. The OWNER may videotape the training sessions for later use with the OWNER'S personnel.

- C. Local Service:** The manufacturer shall have a local service agency (within 50 miles of the site) which maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.

1.8 FACTORY INSPECTION AND TESTING

- A. The CONTRACTOR shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture. This shall include costs for travel, meals, lodging, and car rental for [two] OWNER-designated inspectors for the number of days indicated to complete such inspections or observations, if the place of manufacture, fabrication and factory testing is more than fifty (50) miles outside the geographical limit of the City. The CONTRACTOR shall not be responsible for salary or salary-related costs of the inspectors. The CONTRACTOR shall comply with the requirements of Section 01400.
- B. **Product Testing:** Products shall be tested at the factory for compliance with the indicated requirements. The CONTRACTOR shall provide the CONSTRUCTION MANAGER a written notification of testing dates at least 2 weeks in advance of testing, unless more advance notice is specified elsewhere.
- C. **Balancing:** Rotating elements of equipment, except small, commercially packaged equipment, shall be statically and dynamically balanced at the factory prior to final assembly. The CONTRACTOR shall furnish certified copies of all test results.

1.9 FIELD TESTING

- A. **Testing:** Products shall be field-tested for compliance with the indicated requirements.

- B. **Witnesses:** The OWNER and the CONSTRUCTION MANAGER (at the option of either) reserves the right to witness field tests.

1.10 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. **Delivery of Materials:** Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer. Materials delivered onsite without an approved submittal for verification shall be rejected and payment withheld.
- B. **Storage:** Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.
- C. **Protection of Equipment:** Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weather tight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings. Gears and bearings to be stored for extended periods shall be containerized suitable for export shipment.
- D. **Investigation of Failed Products:** Prior to disposal of failed products, the CONTRACTOR shall investigate the causes of failure and submit a report to the CONSTRUCTION MANAGER, who will subsequently direct the CONTRACTOR for disposal.

1.11 UNIT RESPONSIBILITY

- A. Equipment systems made up of two or more components shall be provided as a unit by the manufacturer of the driven equipment. The manufacturer of the driven equipment shall assume the unit responsibility. Unless otherwise indicated, the CONTRACTOR shall cause each system component to be furnished by the manufacturer with unit responsibility. The extent of the manufacturer's responsibilities shall include engineering the specified equipment, preparation of all submittal materials, coordinating manufacture and procurement, compatibility and shipment of all specified components, design of all equipment supports, providing installation and testing specialists to assist the CONTRACTOR in completing the installation and commissioning the equipment, furnishing factory certified specialists to train the OWNER's staff, and the production and submission of specified operation and maintenance manuals. The CONTRACTOR is responsible to the OWNER for performance of all systems as indicated. The CONTRACTOR shall ensure the submittal of a Certificate of Unit Responsibility signed by the manufacturer with unit responsibility.

1.12 TORSIONAL AND VIBRATION ANALYSIS

- A. **Torsional Analysis:** The drive train shall be free from torsional criticals which produce combined (steady plus transient torque induced) stresses exceeding 30 percent of the material's elastic limit (but no more than 18 percent of the material's ultimate tensile strength) at any speed from 20 percent below to 30 percent above the operating speeds required by the specified operating conditions, or during startup, shutdown or drive control transients. In accordance with MIL STD 167-2, under no circumstances shall combined torsional steady state and transient vibratory stresses exceed 4 percent of the material's ultimate tensile strength, nor more than 50 percent of the material's fatigue limit, whichever is less. Stress concentration factors to be used in the equation:

$$S = Scf \times \frac{(G \times D \times \Delta \theta)}{2L}$$

where:

S	=	stress, psi
Scf	=	stress concentration factor, dimensionless
D	=	minimum shaft diameter, inches, at point of concentration
$\Delta \theta$	=	twist in shaft between adjacent masses, radians
L	=	effective length between masses, inches
G	=	shear modulus of material, lb/in ²

The Scf, to be applied at all the roots of all keyways and changes in shaft diameter shall be as follows:

Scf	Ratio of fillet radius to shaft diameter
4.3	0.0025
3.7	0.01
3.05	0.02
2.75	0.03
2.6	0.04
2.55	0.05 and greater

Values of Scf between data points in the table above shall be based upon a straight line interpolation.

One analysis is required for each piece of unique equipment and for each set of identical equipment assigned to the same application. This general requirement is applicable under the individual equipment specifications or the equipment type general specifications where more detailed torsional, vibration, critical speed, and/or shaft deflection analyses may be required.

The CONTRACTOR shall submit to the CONSTRUCTION MANAGER a torsional and lateral vibration analysis of the following equipment, in accordance with Section 01300. The analysis shall be performed by a specialist who has performed, in the recent past, a torsional and lateral vibration analysis on at least one project of comparable size and complexity. The specialist shall be approved by the CONSTRUCTION MANAGER.

1. All engine drives.
2. All blowers and compressors with drives of 100 horsepower and over.

3. All vertical pumps with universal joints and extended shafts.
4. All equipment with variable speed drives, 25 horsepower and over.
5. All other equipment where indicated.

During construction and testing of all engine driven equipment and all gear driven equipment, the torsional analysis specialist shall visit the site and conduct a field torsionograph test on one randomly selected unit in each set of these equipment to verify the desktop torsional analysis. The test shall be conducted on selected accessible portions of the rotating equipment when operating throughout the full range of specified operating conditions.

- B. **Field Vibration Analysis:** During construction and testing of all engine driven equipment and all [100] horsepower and larger motor driven equipment operating at less than 1,200 rpm, the above mentioned torsional analysis specialist shall make at least two site visits to analyze and measure the amount of equipment vibration and make a written recommendation for keeping the vibration at a safe limit. The vibration analysis is required for each piece of rotating equipment.

PART 2 – PRODUCTS

2.1 GENERAL

- A. **General:** Only products meeting the indicated requirements shall be provided.
- B. **Manufacturers:** Products shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.
- C. **Products:** Materials shall be suitable for the intended purpose and free of defects and shall be recommended by the manufacturer for the application indicated.
- D. **No Endorsement:** The listing of a manufacturer shall not be construed as an endorsement of a particular manufacturer's product, nor shall it be construed that a named manufacturer's standard product will comply with the indicated requirements. No preference is implied by the order of listing of named manufacturers, and the listings are not intended to be comprehensive. The manufacturer listings are only an indication that the OWNER and DESIGN CONSULTANT believe that the named manufacturers are capable of producing equipment and products which will satisfy the indicated requirements.

2.2 GENERAL REQUIREMENTS

- A. **Noise Level:** When in operation, no piece of equipment shall exceed the OSHA noise level requirements for a one hour exposure.
- [B. **Personal Hearing Protection:** The WORK includes multiple sets of three pairs of high attenuation hearing protectors complying with the requirements of ANSI S12.6 and producing a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. One set of hearing protectors shall be stored in a weatherproof, labeled, steel cabinet which shall be mounted in a location near each noise producing equipment installation.]

- C. **Service Factors:** Service factors shall be applied in the selection and design of mechanical power transmission components where so indicated in individual Sections. When not indicated there, minimum service factors shall be 1.25.
- D. **Welding:** Except as otherwise indicated, welding shall comply with ANSI/AWWA D100 and AWWA C206 and the following:
1. Composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds and shall prevent entrance of air or moisture.
 2. Welding shall be by the metal-arc method or gas-shielded arc method described in the American Welding Society's "Welding Handbook" as supplemented by other AWS standards. Qualification of welders shall comply with AWS Standards.
 3. In assembly and during welding, the component parts shall be clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall comply with the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance with uniform weld contours and dimensions. Sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.
- E. **Identification of Equipment Items:** Each item of equipment shall have an indelible, legible identifying mark corresponding to the equipment number indicated.
- F. **Vibration Level:** Except as otherwise indicated, equipment subject to vibration shall be provided with restrained spring-type vibration isolators or pads complying with the manufacturer's written recommendations.
- G. **Shop Fabrication:** Shop fabrication shall be performed in accordance with the shop drawings.
- H. **Tolerances:** The variation in length of members without machine finished ends and which are to be framed shall not exceed 1/16-inch for members 30 feet or less and shall not exceed 1/8-inch for members over 30 feet.
- I. **Machine Finish:** The type of finish shall be the most suitable for the application in micro-inches complying with ANSI B46.1. The following finishes shall be used:
1. Surface roughness of surfaces in sliding contact shall not exceed 63 micro-inches.
 2. Surface roughness shall not exceed 250 micro-inches except where a tight joint is indicated.
 3. Surface roughness for other mechanical parts shall not exceed 500 micro-inches.
 4. Surface roughness of contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall not exceed 32 micro-inches.
- H. **Seismic Design:** The seismic design of equipment shall be based on the horizontal peak ground acceleration indicated in the Geotechnical Report or in the UBC for seismic Zone 4, whichever is greater. Unless otherwise indicated, seismic design importance factors shall be in accordance with Table 16-K of the UBC. Determination of seismic forces and load combinations shall follow procedures in the UBC.

2.3 EQUIPMENT SUPPORTS AND FOUNDATIONS

- A. **Equipment Supports:** Equipment supports, anchors, and restrainers shall be designed for static, dynamic, wind, and seismic loads. The design horizontal peak ground acceleration shall be the greater of that indicated in the Geotechnical Report or as required by the UBC for seismic Zone 4. Unless otherwise indicated, seismic design importance factors shall be in accordance with Table 16-K of the UBC. Determination of seismic forces and load combinations shall follow procedures in the UBC.
- B. **Equipment Foundations:** Unless otherwise indicated, equipment foundations shall conform to the requirements of Section 11002.

2.4 PIPE HANGERS, SUPPORTS, AND GUIDES

- A. Pipe connections to equipment shall be supported, anchored, and guided to minimize stresses and loads on equipment flanges and equipment. Supports and hangers shall comply with the requirements of Section 15020.

2.5 FLANGES AND PIPE THREADS

- A. Flanges on equipment shall comply with ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise indicated. Threaded flanges and fittings shall have standard taper pipe threads complying with ANSI/ASME B1.20.1.

2.6 COUPLINGS

- A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to minimize shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed.
- B. The equipment manufacturer shall recommend the size and type of coupling required for each specific application.
- C. Taper-lock bushings may be used where indicated.
- D. Where universal type couplings are indicated, they shall be of the needle bearing type construction, equipped with commercial type grease fittings. Bearings shall be sized in accordance with ABMA 11, using a 1.25 service factor, for the same L-10 life expectancy as the driven equipment, but not less than 50,000 hours.

2.7 SHAFTING

- A. **General:** All shafting shall be continuous between bearings and shall be sized properly to transmit the power required. Keyways shall be provided in accordance with standard practice.
- B. **Materials:** Shafting materials shall be selected for the type of service and torque transmitted and the effect of corrosive gases, moisture, and fluids shall be considered. Unless otherwise specified, materials shall conform to the following:

1. Low carbon cold-rolled steel shafting: ASTM A 108, Grade 1018.
2. Medium carbon cold-rolled shafting: ASTM A 108, Grade 1045.
3. Corrosion-resistant shafting: stainless steel or Monel, whichever is most suitable for the intended service.
4. Extended shafting: carbon fiber/resin composite.

C. **Differential Settlement:** Where differential settlement between the driver and the driven equipment is indicated, an extension shaft with 2 sets of universal type couplings shall be provided.

2.8 BEARINGS

- A. Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (ABMA).
- B. Bearing selection shall include the following criteria: fitting practice, mounting, lubrication, sealing, static rating, and housing strength.
- C. Re-lubricatable type bearings shall be equipped with an Alemite type hydraulic grease fitting in an accessible location.
- D. All lubricated-for-life bearings shall be factory-lubricated with the manufacturer's best recommended grease to insure maximum bearing life and best performance.
- E. Except where otherwise indicated, bearings for process equipment shall be selected for a minimum L-10 life expectancy of 50,000 hours for intermittent service and 100,000 hours for continuous service, in accordance with ABMA 9 or 11. Anti-friction bearings for pumps with discharge nozzle sizes 14 inches in diameter or greater, or pumps with a shaft diameter greater than 4 inches, shall be selected for an L-10 life expectancy of 100,000 hours in accordance with ABMA 9 or 11. Bearings for other elements in the rotating system such as motors, intermediate shaft bearings, right-angle gears, and flywheel bearings shall be selected using the same criteria as specified for the driven equipment, but not less than 50,000 hours. This requirement supersedes any specified bearing life in the detailed specification sections. Bearing selection shall be based upon the worst combination of continuous duty operating conditions specified and shall include both steady state and transient loads. Commercially manufactured appliances, and small package heating and air conditioning equipment shall be furnished with bearings with L-10 life expectancy of not less than 20,000 hours in accordance with ABMA 9 or 11. Fan bearings shall be rated in accordance with Section 15855. Calculations supporting the selection of bearing sizes shall be included in the Owner's Manual.
- F. Bearing housings shall be of cast iron or steel and the bearing mounting arrangement shall be in accordance with the published standards of the manufacturer. Split-type housings may be used.
- G. Unless otherwise indicated, sleeve-type bearings shall have a Babbitt or bronze liner.

2.9 GEARS AND GEAR DRIVES

- A. Except as otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours at the worst combination of specified operating conditions,

in accordance with ABMA 9 or 11, and a minimum efficiency of 94 percent. Worm gears shall not be used.

- B. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided and installed for easy reading.
- C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
- D. Material selections shall comply with AGMA values and the manufacturer's recommendations. Input and output shafts shall be properly designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.
- E. Oil level and drain location shall be readily accessible. Oil coolers or heat exchangers with all required appurtenances shall be included where indicated.
- F. Where gear drive input or output shafts connect to couplings or sprockets, the gear drive manufacturer shall supply matching key.

2.10 DRIVE CHAINS

- A. Power drive chains shall be commercial type roller chains complying with ANSI standards and of materials best suited for the process fluid.
- B. A chain take-up or tightener shall be provided in every chain drive arrangement.
- C. A minimum of one connecting or coupler link shall be provided with each length of roller chain.

2.11 SPROCKETS

- A. **General:** Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.
- B. **Materials:** Except as otherwise indicated, sprockets shall comply with the following:
 - 1. Sprockets with 25 teeth or less, normally used as a driver, shall be medium carbon steel in the 0.40 to 0.45 percent carbon range.
 - 2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be minimum 0.20 percent carbon steel.
 - 3. Large diameter sprockets with Type C hub shall be cast iron conforming to ASTM A 48, Class 30.
- C. Sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.
- D. Finish bored sprockets shall be provided complete with keyseat and set screws.

- E. Sprockets shall be of the split type or shall be provided with taper-lock bushings.
- F. Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws in both sides of the hub shall be provided.

2.12 V-BELT DRIVES

- A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA, and RMA Standards.
- B. Sheaves shall be machined from gray cast iron.
- C. Sheaves shall be statically balanced. In applications where excessive vibration is expected, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm shall be of materials and construction recommended by the manufacturer.
- D. Sheaves shall be provided complete with taper-lock or QD bushings as required.
- E. Finish bored sheaves shall be provided complete with keyseat and set screws.
- F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.13 DRIVE GUARDS

- A. Power transmission, prime movers, machines, shaft extensions, and moving machine parts shall be guarded. Unless otherwise indicated for corrosive environment, the guards shall be constructed of minimum 10 gauge expanded, flattened steel with smooth edges and corners, galvanized after fabrication and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.14 FLEXIBLE CONNECTORS AND DUAL PIPE COUPLINGS

- A. Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment in accordance with the requirements of the ANSI B31.1.
- B. Dual pipe couplings, separated by an 18-inch pipe spool unless otherwise indicated, shall be installed on the suction and discharge of all pumps - inboard of the isolation valves. Dual pipe couplings, separated by not less than two pipe diameters nor more than 5 feet, shall be installed on all piping where it exits a structure. Couplings shall be restrained where required. Dual flexible pipe joints may be used where indicated in buried pipe applications in lieu of dual pipe couplings. Flexible connectors are not permitted where dual pipe couplings are specified.

2.15 INSULATING CONNECTIONS

- A. Insulating bushings, unions, couplings, and flanges, shall comply with the requirements of Section 15000.

2.16 GASKETS AND PACKINGS

- A. Gaskets shall comply with the requirements of Section 15000.

- B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal," or equal.
- C. Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer.

2.17 TOOLS AND SPARE PARTS

- A. **Tools:** The WORK includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- B. **Spare Parts:** All equipment shall be furnished with the manufacturers' recommended spare parts, as indicated in the individual equipment Sections.

Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

2.18 NAMEPLATES

- A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.19 OVERLOAD PROTECTION

- A. **General:** Where indicated, mechanical or electronic overload protection devices shall be installed on equipment.
- B. **Mechanical System:** The overload protection shall be a mechanical device designed to provide reliable protection in the event of excessive overload. It shall be a ball detent type designed for long term repeatability and life. It shall be infinitely adjustable by a single adjusting nut which shall be tamper proof, and incorporate a torque monitoring and control system. It shall activate an alarm set for 85 percent, and a motor cutout switch set for 100 percent of maximum continuous running torque. A visual torque indicator shall be provided and oriented so that it may be read from the walkway. The dial shall be calibrated from 0 to 100 percent of maximum continuous running torque. The design of the torque limiter should initiate the mechanical disengagement of the drive upon overload. Each unit shall be suitable for outdoor and corrosive environments with a protective finish, corrosion inhibiting lubricants and a stainless steel cover.

- C. **Electronic System:** Overload protection may be an Electronic Torque Monitoring Control System capable of displaying torque, rpm's, one level of overload, and two levels of overload of the drive system. It shall incorporate a time-delay for startup and a voltage monitoring and compensation circuit for up to ± 15 percent variation.

The overload device shall have an enclosure suitable for outdoor installation at temperatures of 0-70 degrees C, and relative humidity up to 95 percent. A visual torque dial shall be provided and oriented so that it can be easily read from the walkway.

The torque monitoring system shall be calibrated to include: alarm and shut down the system in the event the torque drops to 50 percent of normal running; alarm at 85 percent of maximum continuous running torque and shut down the motor at maximum continuous running torque of the equipment. The system shall be calibrated at the factory of the equipment manufacturer and it shall be capable of monitoring twice the maximum continuous running torque of the equipment.

- D. **Definition:** For the purpose of these Specifications, "maximum continuous running torque" shall be defined as the lesser of: the motor continuous running torque rating, the gear drive continuous running torque rating, or the driven mechanism continuous running torque rating, not exceeding a service factor of 1.0.
- E. **Manufacturers:** Overload protection devices shall be manufactured by the following (or equal):
1. American Autogard Corporation
 2. Ferguson Machine Company

2.20 ANCHOR BOLTS, NUTS AND WASHERS

- A. Unless otherwise indicated, anchor bolts, nuts and washers for anchoring equipment to foundations and connecting bolts for equipment assemblies supported by other assemblies shall conform to the requirements of Section 05500. Unless otherwise specified, the CONTRACTOR shall provide Type 316 stainless steel anchor bolts and washers, and Type 416 stainless steel or other corrosion resistant, non-galling alloy nuts. In ferrous chloride and ferric chloride containment areas, unless otherwise specified, provide Hastelloy C or Alloy 276 anchor bolts, nuts, washers and connecting bolts.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. **General:** Products and equipment shall be installed in accordance with the manufacturer's written installation instructions, the requirements of this Section, the requirements of the individual equipment specifications, and as indicated.
- B. **Alignment:** Journeymen millwrights shall perform alignment of equipment furnished under this Section and any referencing section. Carpenters, laborers or any other trades are specifically excluded from performing this work. In locations where such trades are not available, the CONTRACTOR shall retain the services of a firm specializing in this type of work to perform the setting and alignment work. The CONTRACTOR shall submit the qualifications of the proposed firm to the CONSTRUCTION MANAGER for acceptance prior to performing the work. The CONSTRUCTION MANAGER shall personally witness final alignment procedures for each item

of equipment as a condition precedent to beginning any work required under Section 01660. Alignment techniques shall conform to the requirements of Section 11005.

- C. **Lubricants:** The CONTRACTOR shall provide for each item of mechanical equipment a supply of the lubricant required for the commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the OWNER's current lubricant supplier. The CONTRACTOR shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment, the CONTRACTOR shall provide the OWNER with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

3.2 COUPLINGS

- A. Couplings shall be installed in accordance with the manufacturer's installation instructions.

3.3 INSULATING CONNECTIONS

Insulating connections shall be installed in accordance with the manufacturer's instructions.

3.4 PIPE HANGERS, SUPPORTS, AND GUIDES

- A. Hangers, supports, and guides shall be installed in compliance with ANSI/ASME B31.1 and with Section 15020.

3.5 BOLTS AND MISCELLANEOUS METALS

- A. Bolts, including anchor bolts, and miscellaneous metals shall comply with paragraph 11000-2.20 and Section 05500. Installation of equipment anchor bolts shall comply with Section 11002.

3.6 PACKAGED EQUIPMENT

- A. When any system is provided as pre-packaged equipment, coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.7 PROTECTIVE COATING

- A. Equipment shall be painted and coated in accordance with Section 09800. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

**** END OF SECTION ****